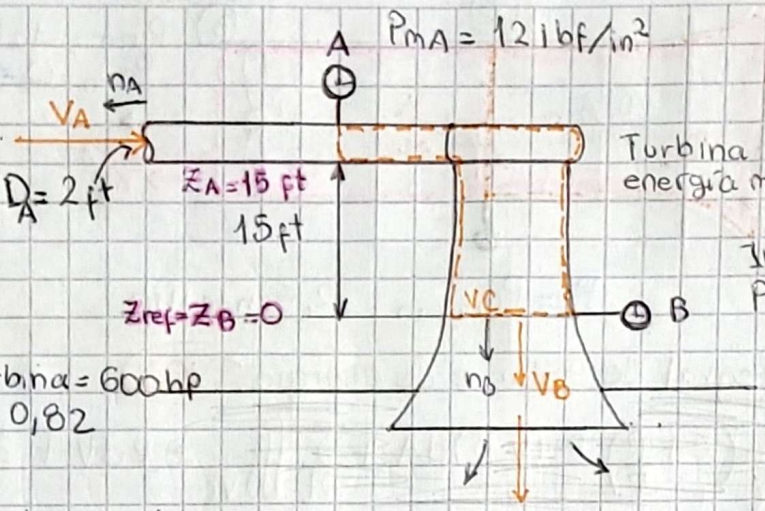
Problema 3



Turbina hidráulica: genera energía mecánica o eléctrica

fluido = Agua
$\rho_{H_2O} = 1000 \frac{kg}{m^3}$

Incógnita
$P_{mB} = ?$

Potencia de la turbina = 600 hp
eficiencia = $\eta = 0,82$

Planteo la Ec. Integral:

$$\frac{\partial Q}{\partial t} - \frac{\partial W_s}{\partial t} = \iint_{SC} \left(e + \frac{p}{\rho}\right) \rho (\vec{v} \cdot \vec{n})\, dA + \frac{\partial}{\partial t} \iiint_{VC} e \rho\, dV + \frac{\partial W_u}{\partial t}$$

Consideraciones

- $\frac{\partial Q}{\partial t} = 0$ No hay intercambio de calor del VC con el entorno
- $\frac{\partial W_s}{\partial t}$ = 600 hp (Potencia real) Trabaja con $\eta = 0,82$ $\Rightarrow \eta = \frac{\text{Potencia Real}}{\text{Potencia ideal}}$ $\eta < 1 \Rightarrow P_{Real} < P_{ideal}$

$$\text{Potencia ideal o teórica} = \frac{\text{Potencial Real}}{\eta} = \frac{600\ hp}{0,82} = 731,71\ hp$$

• En la Ec. Integral se trabaja con la potencia ideal o teórica.

- EE → Acumulación = 0
- $\frac{\partial W_u}{\partial t} = 0$ despreciable

• $e = e_p + e_c + e_i$
$e_i = 0$ No hay variación de temperatura

- $\rho_{H_2O} = cte$ FI, $T = cte \Rightarrow Q_{mA} = Q_{mB}$ / $Q_{VA} = Q_{VB} = Q_V$

Como el $D_A << D_B \therefore A_A << A_B \Rightarrow V_A >>> V_B \Rightarrow V_B \simeq 0$

Entonces la Ec. Integral queda:

$$-\frac{\partial W_s}{\partial t} = \left(e_{P_A} + e_{c_A} + \frac{P_A}{\rho}\right) \rho\, V_A n_A \cos 180° A_A + \left(e_{P_B} + e_{c_B} + \frac{P_B}{\rho}\right) \rho\, V_B n_B \cos 0° A_B$$

$$-\frac{\partial W_s}{\partial t} = \left(g z_A + \frac{V_A^2}{2} + \frac{P_A}{\rho}\right) \rho (-Q_V) + \left(\frac{P_B}{\rho}\right) \cdot \rho\, Q_V$$

$$-P_B \cdot Q_V = -\left(g \cdot z_A + \frac{V_A^2}{2} + \frac{P_A}{\rho}\right) \rho \cdot Q_V + \frac{\partial W_s}{\partial t}$$

$$P_B = \frac{\left(g \cdot z_A + \frac{V_A^2}{2} + \frac{P_A}{\rho}\right) \rho\, Q_V - \frac{\partial W_s}{\partial t}}{Q_V}$$

$P_B = 221.636,17\ Pa$

$z_A = 15\ ft = 4,57\ m$

$Q_{VA} = V_A \cdot A_A$ $\quad Q_{VA} = 5,66 \frac{m^3}{s}$

$V_A = \frac{Q_{VA}}{A_A} =$ $\quad A_A = \pi \cdot \left(\frac{D_A}{2}\right)^2$

$V_A = 19,52 \frac{m}{s}$ $\quad D_A = 2\ ft = 0,61 m$

$A_A = 0,29\ m^2$

$P_A = 82.737,12\ Pa$

$\frac{\partial W_s}{\partial t} = 545.636,15\ W$